THE TRENTON ROCK AND GAS SUPPLY.

BY PROF. EDWARD ORTON.

Trenton rock, or more properly, Trenton limestone, is the name of a geological formation that was first noted in Oneida county N. Y., some fifty years ago, where, in the deep gorge of a water-course, limestone walls containing well-preserved fossils characteristic of the division of geological time known as the Lower Silurian Age, were found. The rocks of this period had received no local name in North America, so they were christened Trenton limestone.

Trenton limestone, which has acquired such fresh and mighty importance of late, is a dark blue, almost black, rock, lying in massive, even beds, which are sometimes separated by layers of thick shale. The limestone has a thickness of about 150 feet. It is covered by a a stratum of 300 feet of thin-bedded, dark shale, which is sometimes mistaken for coal. The shale is called the Utica slate or shale.

Trenton limestone was the first great limestone formation on the continent, and was much wider than any that succeeded it. It is found all over most parts of Eastern North America.

How was it formed?

When I spoke of the fossils that are discovered in it I gave a hint as to its origin. The limestone was built up by them and of them. It grew in a shallow sea, beneath which the future continent of North America was outlined.— When the Teenton limestone was growing in its tropical ocean the earth knew but a single climate; it was the same from the pole to the equator. Warm water and a mild atmosphere prevailed, and the same life grew and multiplied from the Arctic Ocean to the Gulf of Mexico. Organic matter from the tissues of the various animals whose shells and structures contributed to the forming of the rock, were incorporated in this limestone.

At last it was completed and a new period of geological history began. The limestone was covered with a deposit of fine-grained fossiliferous brown or black shale, now called the Utica.. Above the Utica were slowly deposited the shales and limestones of the Hudson River or Cincinnati group, gray or blue in color and five hundred to a thousand feet in thickness. Above this formation the Medina was laid down, a mass of red rocks, sometimes sandstone and sometimes shale. Then a slow succession followed the several members of the Upper Silurian and Devonian limestones, the Clinton, Niagara, Lower Heidelberg and Upper Heidelberg limestones.

UTILITY OF TRENTON LIMESTONE.

The uses of the Trenton limestone are manifold. It yields the magnificently fertile soils of the Kentucky blue grass region. It furnishes building stone and lime for the world. At some points, notably in Vermont, Pennsylvania and Tennessee, it is the basis of rich

marble quarries, and in the Galena district of Northern Illinois and Wisconsin lead ore is found in the first eighty feet of this formation. At lower depths mineral water of value in a medical way flows from the Trenton limestone, and petroleum has long been discovered in it in small quantities at various points.

Trenton limestone has become an object of general interest because of the surprising developments of oil and gas in Northwestern Ohio.

The gas wells and oil wells go to the Trentou limestone for the supply of fluids which they bring to the surface of the earth, hence every one in that part of the country wants to know something about rock in this State.

TRENTON LIMESTONE IN OHIO.

Trenton limestone underlies the entire State of Ohio, and its existence has been thoroughly demonstrated in the western half by drilling done in the more than thirty counties within the last year.

There is but a single locality in which it comes to the surface, and that is in the valley of the Ohio, fifteen miles above Cincinnati, at the quarries of Point Pleasant. Here a few feet of Trenton limestone are uncovered just above low water mark, at the bottom of the furrow which the Ohio River has worn for its bed. The limestone rocks that are visible here long have been known as the lowest rock of the State. The surface of the Trenton limestone at Point Pleasant is about 450 feet above tide water. This is the greatest elevation the stratum reaches in Ohio. In Kentucky it rises several hundred feet higher. From Point Pleasant the Trenton rock descends northward across Ohio, at the rate of from three to ten feet to the mile. To the eastward it falls more rapidly, and to the west not so rapidly.

There are numerous small rolls and some abrupt breaks that mar the regularity of the northward descent, but over large sections the fall is quite steady. At Cincinnati the surface is about 325 feet above the sea; at Hamilton, 215; at Middleport, 117. A little east of Eaton it reaches sea level, and at Dayton is 120 feet below tide; Washington C. H., 285 feet below.

At Greenville, in Darke county, it is 81 feet below sea level; at Union City, 40 feet below; at Piqua, 307 feet; at Urbana, 300 feet; at Sidney, 269 feet; at Bellefontaine, 340 feet; at Magnetic Springs, 650 feet; at Celina, 235 feet; at St. Mary's, 313 feet; at Wapakoneta, 348 feet; at Van Wert, Van Wert county, 434 feet; at Delphos, 447 feet; at Lima, 400 feet; at Kenton, 560 feet; at Marion, 707 feet; at Ada, 478 feet: at Upper Sandusky, 472 feet; at Bucyrus, 1,235 feet; at Findlay, 310 to 500 feet; at Carey, 513 feet; at Fostoria, 472 feet; at Tiffin, 731 to 800 feet; at Sandusky, 1,627 feet; at Fremont, 700 feet; at Oak Harbor, 713 feet; at Toledo, 800 feet.

ORIGIN OF GAS AND OIL.

The oil and gas deposits in the Trenton limestone doubtless owe their origin to animal and vegetable matter that was deposited in the limestone when it was forming, and the probability is that most of the matter so incorporated was animal in its nature, because the limestones were built up by means of animal agencies, and there must be organic matter in them. But organic matter has to take some

more permanent form, and when it has reached a stable condition the flight of ages does not, of necessity, alter or disturb it.

It is a common mistake to consider oil a rare substance in nature. It is not rare, but is universally disfused among stratified rocks, except where they have been transformed by heat. It generally occurs in small quantities, but the aggregate is immense.

Throughout Northwestern Ohio the drill first passed through from 300 to 1,000 feet of Upper Silurian and Devonian limestones, and the total quantity of oil in the so-called unproductive part of the well is greater than any supply ever found at the bottom of the well.

These upper limestones often show one-fifth of one per cent. of petroleum, and every hundred feet of such limestone would yield more than a million barrels of oil to each square mile, which is greater than the production of the richest field. The point is that this oil can not be accumulated.

Where was this petroleum formed? Along the shores of those measureless seas in ancient days where the limestone was deposited there was formed the oil that men now seek with drill and pump. The petroleum was formed by a peculiar decomposition of animal and vegetable substances, and it is not one of nature's lost arts. The process still continues, but on a smaller scale. Petroleum can be formed by heat and distillation, but it can also be formed without high temperatures, and all the great sources fall in the last category. Petroleum is breaking up into gas, but there does not appear to be sufficient reason to think that much new petroleum is forming. The quantity already in the storehouse of the earth is so vast that there hardly seems room for fresh additions to it. All the stocks of petroleum that are known of are the results of accumulation continued through vast periods of past time —periods which years are as inadequate to measure as miles are to compute the distance to the sun.

RESERVOIRS OF OIL AND GAS.

The Trenton limestone underlies all of Western Ohio and is everywhere saturated with oil. Few wells have been drilled into it without showing the presence of gas and oil, at least in small quantities. To be of value in a practical way, petroleum must be concentrated and accumulated like other forms of mineral wealth. For this accumulation there must be a reservoir, more or less porous; there must be a covering to the oil rock that is impervious, and the oil rock must have a peculiar structure or arrangement.

The Trenton limestone is at once its own reservoir and source for all its stock of gas and oil. In this respect it differs widely from the Pennsylvania oil rocks. They are sandstones and conglomerates and the oil and gas in them found entry from below, the underlying shales being the sources of both fluids. So there the oil-containing and oil-producing rock are distinct but all this is changed in the Trenton limestone of Ohio.

The upper beds of the Trenton are frequently porous to a marked degree. These porous beds are differently distributed in different parts of the same field. Sometimes such a bed is found at the very top of the Trenton so that the first stroke of the drill penetrates it, but

most frequently the porous beds are deeper. The sources are universal, and the reservoirs widespread, so the conditions are favorable for an enormous production.

An impervious covering for the oil rock is the second essential condition to accumulation. For the Trenton limestones, the Utica, Hudson and Medina shales afford a ubiquitous and admirable covering.

The next important element in the way of facilitating accumulation of oil deposits is the structure of the rock, or arrangement of the strata, with reference to its dips, breaks and faults. Gas accumulations are particularly dependent upon certain peculiarities of structure, upon departures from what may be considered the normal condition of the limestone. The Findlay field burnishes a marked instance of this effect of structure.

It is along the edge of the "Findlay break," and from the summit of the low arch on the boundary between Wood and Hancock counties, that most of the dry gas is produced. On the east side of Findlay the Trenton limestone is found in a flat terrace 310 to 340 feet below the tide. On the western side it descends with an abrupt pitch at the rate of one foot in ten, to a level of 470 feet below tide-water. On the upper terrace and on the edge of the break dry gas is produced. Further down the slope oil and gas are found together, as oil and salt water are found with enough gas to raise the oil to the surface. The main street of Findlay almost marks the break in the structure; east of it gas is found and no oil and west of Main street oil with little or no gas.

In the North Baltimore wells the Trenton limestone is 380 feet below tide. At Braidstown it is 315 feet below, and at the Simons gas well 300 feet; at Bloomdale, 310 feet; and at the Godsend gas well, five miles from Fostoria, it is 380 to 390 below tide.

The Van Buren gas wells show the same high levels of the limestone, and the Bowling Green wells come to the same catagory.

In no instance does dry gas in this field come from a level more than 400 feet below tide. The three largest wells are the Great Karg, at Finday, the Van Buren and the Simons wells north of it. In the first the Trenton rock is 347 feet below tide, in the second 330 feet, and in the third 301 feet below tide.

In all of the good wells that have been struck, with perhaps a single exception, the surface of the Trenton limestone ranges between three and four hundred feet below tide. These figures are very significant when it is remembered Ohio has a range of more than two thousand feet, from 450 above tide in the Ohio valley to 1,600 below at Sandusky, and all of the gas of real, practical importance is had from the few localities in which the limestone has the levels that have been noted and where there is a fractured or abnormal structure.

The statements of the drillers prove that not a single well in Northwestern Ohio is producing oil from Trenton limestone where it lies more than five hundred feet below the level of the sea, and not a single well is emitting gas in quantities 1,000 cubic feet daily where the top of the Trenton rock lies more than four hundred feet below tide water. All of the gas wells of Ohio combined that get

their gas from a lower level lack in aggragate do not yield more than volume and pressure, and in the two thousand cubic feet of gas daily.